STATE OF ILLINOIS
HENRY HORNER, Governor

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EDITED BY GRACE NEEDHAM OLIVER

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TRANSACTIONS OF THE ILLINOIS STATE ACADEMY OF SCIENCE

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ANNOUNCEMENTS

The Committee on *Research Grants from the American Association for the Advancement of Science* announces that each year $200 is granted the Academy for use in the aid of research projects. Requests for small grants from this fund will be received up to February 1, 1941, and should be accompanied by a detailed statement of preceding background, general purpose, and estimated expenses. All such requests should be supported by three letters of recommendation sent directly by the writers. Customarily grants are made only to scientists connected with smaller institutions within the State. Correspondence should be directed to W. O. Blanchard, Geology Department, University of Illinois, Urbana, Illinois.

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APPLIED SCIENCE AS IT AFFECTS OUR ENGINEERING*

W. H. RADFORD**

THE CATERPILLAR Tractor Company is glad to have the opportunity of participating in this meeting and appreciates the honor of presenting its conception of physics requirements for the young engineer who wishes to associate himself with its type of industry. It does not presume to judge of requirements in other industries, and it believes that in order to complete the picture certain other requirements should be discussed which make for success or failure and which are not necessarily attainable in college training.

The Company has asked me to present this paper because training of men is a subject very close to my heart, and not because I possess any outstanding ability as an orator. I shall try to be constructive in any suggestion I may offer, and I trust you will so regard those suggestions. Standing before this representative audience of professors and physicists today, there is just an indication on my forehead of the cold beads of perspiration which, in college days, stood out in profusion when I entered the presence of the professor with my assignment badly prepared. I may deviate from the technical limitations implied in the title of this paper, but I shall try to present this subject on a practical basis.

We have then to consider the training of engineers for an industry embracing the design, manufacture, sale, and use of engines, power units, tractors, road machinery, and associated equipment. This is a rather broad line to cover. It requires knowledge in several branches of engineering—mechanical for the application of physics to design of prime movers and the devices for transmission and application of power; metallurgical for the characteristics and treatment of metals from ore to finished product; chemical for composition of ferrous and non-ferrous alloys, fuels, lubricants, and gases; electrical for design and application of motors, generators, and instruments; civil in earth moving, road building, and excavation; agricultural for soil characteristics, soil working, terracing, planting, cultivating, and harvesting. There are others, but these will suffice to indicate the range of application.

Efforts to make improvements, changes in, and additions to our industry's products to fit them for an ever increasing number of uses may easily end in chaos if the development disregards the basic laws of physics. Because of the wide range of products in our industry, the development must be orderly, with a personnel trained in fundamentals, cooperation, and due respect for a wisely applied pinch of the salt of experience.

If we visualize the plan of industry from the doorway of the basic laws of physics, we will recognize how engineering has applied those laws. The production application of the laws will be reflected in the design, fabrication, assembly, and operation of the products. The maintenance of uniformity in the product from the standpoint of performance will be the result of physics applied in the measurement of power, efficiency and routine commercial testing. More distantly revealed in the product and its standards of performance will be the phases of development by physical laws applied in experimentation and commercial and fundamental research. Through sales and service to its useful work for mankind there still will follow some need of those same fundamental laws.

Out in front of this picture are the challenges which urge us on to greater and greater efforts to produce better materials and methods with which to increase efficiency and produce longer product life. We can design better power plants and machinery when we have materials which will withstand stresses

* Paper presented before the Physics Teachers of Illinois, meeting concurrently with the Academy of Science. The Academy Committee on Publications considered it important enough to print for the benefit of the general membership.

** Assistant Chief Engineer, Caterpillar Tractor Company.

of 1500 lb. at 900° temperature; when we know how to produce perfect combustion of fuel; when lubricants will not break down at 350°; when we lessen the distortion of metals under heat; when dust and dirt can be entirely excluded; when we can make non-lubricating surfaces more resistant to wear; when we can eliminate corrosion; when we can automatically dispose of the products of ordinary use and wear. The list is endless and the ultimate is a product which a fool cannot harm.

Let us now review some more concrete examples of the engineering application of physics in our industry. The design of the product involves probably more of the comprehensive field of engineering physics than any other phase of the business in calculation, computation, and reasoning.

The entire field of statics is covered in the use of force diagrams, moments, couples, centers, and equilibrium in the design of gear teeth, flywheels, clutch level linkage, connecting rod sections, track roller frames, motor grader frames, tractor frames, power unit frames, track shoe grouser placement, general tractor, motor grader, and power unit proportions, center of draft, articulation of track trucks, etc.

For consideration of bodies in motion, we find that knowledge of the fundamentals of dynamics, recognized by the familiar "Force=Mass times Acceleration" equation, plays a most important part in design problems—forces in pistons, connecting rods and reciprocating assemblies; in springs and assemblies they actuate; in flywheels, gear trains, tracks, and all rotating masses; in frequencies of springs and dampening of harmonics and surges; in moving oil columns in lubricating systems and fuel lines; in tortional vibration in crankshafts; in losses through clutches, brakes, piston and rings, oil seals, belts, and other results of friction; in balancing tractors, graders, and other machines so that they can operate without failure at various angles and positions; in momentum of flywheels, gear trains, vibration dampers, and of entire machine assembly; in determination of impact loads by spring operated assemblies and supporting sections, or by operation of machines over all kinds of terrain and at various speeds; in hundreds of other examples of the engineer's ordinary bread and butter.

In dealing with solids we must know about modulus of elasticity, yield point, ultimate strength, ductility, hardenability, erosion and corrosion resistance, fatigue, and other properties of materials; the hysteresis and dampening effect of rubber or synthetic rubber compounds; the specific gravity and density of materials so that the wisest selection of materials can be made which embraces the required qualities.

A knowledge of the physical properties of liquids is necessary to make any intelligent use of their applications. This subject is very often neglected. One must know such properties as surface tension and its effect on oil adhesion, thickness of oil films, lubrication properties of oils and fuels, action of oil columns under pressure, weight and specific heat of fuels such as gasoline and kerosene for the design of hot or cold manifolds, effect of restriction and change of sections on moving liquids in cooling, lubricating, and fuel systems.

Properties and effects of air and gases at rest and in motion under heat and pressure sometimes challenge the physicist's knowledge. For the cycles in engines, Boyle's and Charles' laws are still fundamental and simple but not so easy are the problems involved in getting air or mixtures into engine cylinders; in calculating attendant friction losses and the temperature rise and heat transfer through air or gas; in designing manifolding and combustion chambers; in designing radiators and fans, and more recently superchargers for restoring power lost by altitude operation; in the action of gas and air moving together to cause vaporization or atomization of fuel as in carburetion or injection equipment.

The branch of physics dealing with various wave motions and wave phenomena has a definite use in locating noise which is the result of periodic motion in machinery, longitudinal and transverse waves in air, combustion and injection pressure waves, wave motion in steel sheets and other construction members, including large castings. A knowledge of the detection of such motion affords the opportunity to apply corrective measures for this class of defect which very often cannot be foreseen in original design. These laws of wave

motion apply in the design of crankshafts, gear trains, fluid flow in injection apparatus, to prevent destructive forces.

In the realm of heat is required familiarity with boiling and freezing temperatures of liquids for cooling systems, knowledge of heat transfer from surfaces, and the coefficients of heat transfer in materials which vitally affect piston and piston ring design and thickness of cylinder walls and engine cooling cavitation. The coefficients of thermal expansion are important in designing for proper clearances in valve trains, clutches, bearings, and similar problems. Specific heats are used to determine the amount of coolants which must be circulated by pumps.

The fundamental laws of electricity and magnetism are used in the design of magnetos, generators, and starting motors; of simple lighting and wiring diagrams used at times in tractor and motor grader lighting; of switch board control for engine-generating units or special electrical apparatus for carrying on tests of engine generator products. Knowledge is necessary of the principles of operation, the limitations and the sizes of direct and alternating generators and motors.

A different collection of fundamentals could be cited from a knowledge of the requirements demanded by the manufacturing phase of the industry. Manufacture which includes fabrication, processing, and assembling deals with forces required to operate stamping, forging, pressing, and mechanical advantage machines. It deals with aids which eliminate inconsistencies in assembly such as definite length of leverage wrenches and direct torque reading wrenches for stressing assemblies to a predetermined load. The laws of gravity and friction are used in arrangements which transport material from place to place. The expansion and contraction of parts with proper application of heat are commonly and widely used in assembly of bearings, valve seat inserts, and other tightly fitted parts. Necessary is the knowledge of cutting oil viscosities, oiliness and cooling properties in lubricants used with cutting tools; of properties of compressed air as a source of power for assembly tools; of hydraulics used in drives and controls for machines; of temperature control for maintaining precise measurements of related high precision parts and equipment; of the laws of conservation of energy which are important in the efficiency of equipment and personnel and are usually translated to read, "Maximum work with minimum effort." Knowledge of electricity and magnetism in the manufacturing phase is useful for various reasons. Magnetic holding and lifting devices speed up quality work. Electrostatic air filtering systems for cleaning dusty places are widely used. Problems of resistance heating in heat treating equipment, and the use of resistors and capacitors in the control of such devices have been applied for a long time and are being extended to induction heating and quenching processes for selective hardening in crankshaft bearings and many other parts. Inspection makes use of X-ray machines and magnaflux to determine soundness of castings or important stress members.

In foundry work we must know the fusion points of sand and metals; the means of elimination of physical impurities by gravity such as in slag removal; the placement of risers in the mold; the direction and velocity of flow of molten metal; the materials which, when mixed with others under certain conditions of heat or atmosphere will give required properties to the mix.

In plant engineering we are concerned with the construction of plant building; with heating and ventilating of buildings involving movement of large volumes of air; with cooling and exhausting fans for conditioning air in offices, paint shops, carpenter shops and foundry; with the entrainment of water in air streams under high pressure for cleaning and washing processes; with the mounting of high speed and precision machine equipment to eliminate vibration or to isolate from disturbing vibrations; with elimination of objectionable noises and with improvement of illumination for increased safety and accuracy.

In the testing of materials and the products, one needs to know the physics employed by a wide range of testing machines and instruments. Tractors and motor graders will use field traction dynamometers or will move dirt or some kind of equipment. Engines and power units will be hooked up to hydraulic or electric dynamometers or other power absorption units. Materials will demand the use of tensile, torsion, compression and impact machines.

In the field of other instrumentation, the engineer will encounter the use of the stroboscope for arresting motion to study moving parts; of the piezo-electric properties of crystals in producing currents when under pressure; of heat measuring instruments such as calorimeters, thermocouples, pyrometers, and fusible materials; of cathode ray oscillograph in combustion studies, torsional vibration and spring surge; of vibration pickups used with the oscillographs for torsional and other vibration tests; of photo-electric cells for controls and density detection; of the properties of condensers, radio circuits, vacuum tubes, instruments for measuring sound levels, microphones used with the oscillograph for measuring sound frequencies; of lenses and optical equipment such as cameras, projectors, telescopes, microscopes; of polarized light and its application to the examination of stresses in photo-elastic materials; of optical flats and profilometers for measuring the degree of perfection of surfaces; of many other instruments which I haven't time to mention.

For the research and development fields of the industry, fundamental work is going on in fuel injection equipment involving hydraulic and mechanical stress, strength and fatigue of materials; in the thermodynamic analysis of engine combustion efficiency; in sound frequencies of gases producing combustion detonation; in fuel spray penetration, drop size and velocity; in the ignition quality and power producing qualities of fuels; in the problems of compounding lubricating oils; in the hysteresis effects of rubber and steel; in the properties of bearings for low coefficients of friction, higher melting points, and greater load capacity. The list is endless.

Now that I have made a necessarily dry recital of some of the technical requirements in our industry, let us consider the personal element factor in the problem and the means at hand for selecting young physicists and placing them in industry where they can best serve themselves and their employers.

I believe that a comparatively small percentage of engineering graduates are temperamentally fitted to compete in a large industry, and there are others who seem unable to acquire a liberal knowledge no matter what the educational opportunities may be. But whatever knowledge is absorbed helps to place the recipient in a better position to make at least a degree of success in life.

Some people claim that an engineering education is wasted on most young men. I cannot agree with this extreme view. I believe that engineering offers one of the best preparations in logical thinking for any kind of business or walk of life. As in any other profession, not all can reach the top, but there are many nitches to fill in industries of various magnitudes. One great service our educational institutions can give to the young man and to industry is to help him to select a level that is compatible with his inherent ability, and to teach him to be satisfied with the degree of success which such a level can give. The man of only average ability should not be placed in a large industry where competition of other men will submerge him. He should be placed where he can have more time to develop, or where the ultimate goal is less difficult to reach.

We too often find young college men imbued with an exaggerated idea of their value to industry, and it is rather difficult at times to impress them with the fact that industry is making an investment in them on which it cannot expect returns for several years. On the other hand, to work through that period before industry sees the returns is the toughest part of a young engineer's career, and what a tragic disappointment it is to him if he has selected an industry which does not recognize when the time has arrived to pay him dividends on the returns. Here again colleges can give good advice to the young engineer for estimating his own value and for making his choice of a career with a fair dealing industry. We believe we are a fair dealing organization.

In selecting young engineers for our organization, we try to choose those who will be able to advance and grow as we grow; those who show evidence of intelligence, vision, and ability; those who have promise of carrying on when we are no longer able; those who appear trustworthy and have commanded the respect of teachers and fellow students.

We stress the value of a high academic rating and of accomplishment in a chosen course as being an indication of expected rapid development. We regard participation in extra curricular activities as indication that there is a natural liking for others and that leadership will result. We feel certain that contribution to the

expense of education brings earlier maturity, better sense of values, and a surer foundation on which to place responsibility.

We inquire into the young man's pleasures, hobbies, and means of recreation, and family life. Every young man must learn how to work, and he should know how to play. Only happy men can attain the highest accomplishment.

Because our industry embraces many branches of physics and engineering, we want men who are broadly and thoroughly grounded in as many fundamentals as possible. We require knowledge in civil, mechanical, electrical, metallurgical, chemical, agricultural engineering, and the application of these branches overlap in design and use of many of our products. The important thing is that we have men who have been taught how to think and organize their thoughts, and where and how to look for information. This may be an age of specialists, but a young engineer just graduating is in no position to choose a highly specialized line. It narrows his opportunity while he is young and prevents a possible wiser choice later on when he has had a chance to get a broader view of the work which industry has to do. Our experience shows that his preferences for certain lines of work rapidly change during the two years of his training. These lines of work may not be what we choose to call strictly engineering. They may include sales, service, purchasing, or other lines for which he may develop aptitude, but which will probably require training in the engineering department beyond his two year period. It is essential that he have no preconceived ideas of a definite path of advancement. Such advancement must be left to our judgment.

Entering our training course should be regarded as a further opportunity for education and not as a probational period to be endured while the world is anxiously waiting to be turned upside down. The engineer in training should study the products and methods of manufacture which he encounters and attempt to interpret them in terms of what he has learned in college. If he conscientiously tries to do this he will soon discover that the compromises which have to be made with the pure dictates of physics in producing a product which is saleable and which will satisfactorily serve mankind, require a knowledge of the application of physics which cannot easily be attained in academic training. These compromises are the unpredictable headaches which accumulate to make for experience. Nothing in a young engineer's training can make up for that experience, and it is best he learn early in his career that the gray hairs in the chief engineer's head are an indication of tough problems solved and not a proof that senility is submerging his knowledge of physics and its application to the work at hand.

With the thought in mind that the period of training in industry is very definitely an opportunity to gain further knowledge, the graduate must apply himself diligently to work immediately before him. It means hard work, but work for which he is being paid. That present job in front of him must be the most important thing on his mind. There is nothing he can do about what is past. He cannot take the time to dream about the future, which must always be more or less obscure, for time so spent does not register with a training supervisor. The job at hand conscientiously and enthusiastically done is the only road to future success. Now the job at hand is very often not a pleasant one, for we expect him to learn to use his hands as well as his head, and those hands are sure to be initiated into dirt and grime; but still the necessity exists for knowledge of how dust, dirt, grime, and other adverse agencies affect the fabrication and successful use of our products.

To do his work day by day, he must cooperate with those with whom he comes in contact. Cooperation of many individuals is the foundation on which successful industry is built. A lone wolf hasn't a chance, and a lone wolf engineer in training endeavoring to show authority and superiority soon finds barriers which he is not able to cross alone and realizes too late that by his attitude he has placed himself in a position where fellow workers or supervisors cannot help him. There are plenty of men who seek authority. There are comparatively few who are willing to assume the responsibility, which comes from taking the hard knocks and accepting the challenge of problems involved in fitting themselves into a large organization. Once prepared to take responsibility, they will find that the necessary authority naturally follows, and opportunities for constructive changes become the ordinary every day work.

During two years of training, our young engineer must not only become familiar with the materials we use and how they are processed, assembled, and tested, but also how to conduct himself in his personal contacts. It is essential that he learn the languages of all from sweeper to president, for problems will be put before him in all those languages. His will be the task of interpretation in terms of engineering or applied physics in order to solve those problems.

In conclusion, I wish to say that our educational institutions are doing an excellent job of training, considering that many of them have inadequate equipment and personnel. Industry cannot expect them to solve its problems, but it does expect them to make a thorough job of teaching a broad range of fundamentals.

I wish to acknowledge the help given me by our young graduate trained engineers in the preparation of lists of physics requirements in this paper.

LOOKING THROUGH GREAT TELESCOPES

OLIVER JUSTIN LEE*

While showing this six-reel panorama of celestial objects I mentioned a number of focal points of emphasis in current research in Astronomy. Among these are:

1. Nature and interplay of forces which give instantaneous increments of velocity to solar prominences. 2. Exhaustive studies of unusual stars such as Novae, Epsilon Aurigae, Gamma Cassiopeiae, etc. 3. The mechanism of stellar radiation. 4. Extension of studies to fainter classes of stars. 5. Amount, nature and distribution of interstellar material in our galaxy. 6. Testing the reality of an "expanding universe."

This film was made from prints of the best negatives of the various objects obtained at the Mount Wilson, Lick, Lowell, Yerkes and Harvard Observatories. The directors of these institutions cooperated with Mr. Sibley and myself in the most generous manner in making this picture possible. Figs. 1 and 2 are taken from the film.

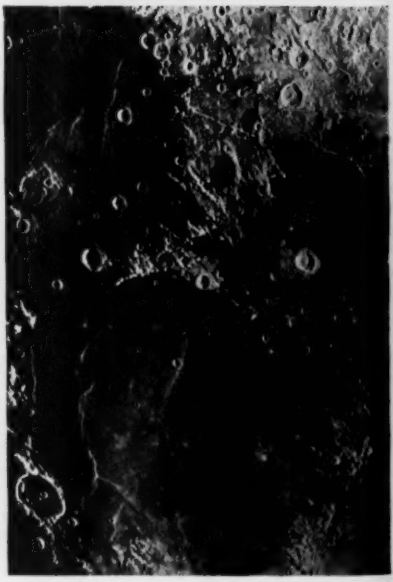


Fig. 1. Top—Nebula in Sagittarius. Bottom —Mare Tranquilitatis and Mare Serenitatis on the Moon.

* Director Dearborn Observatory, Northwestern University, Evanston, Illinois.

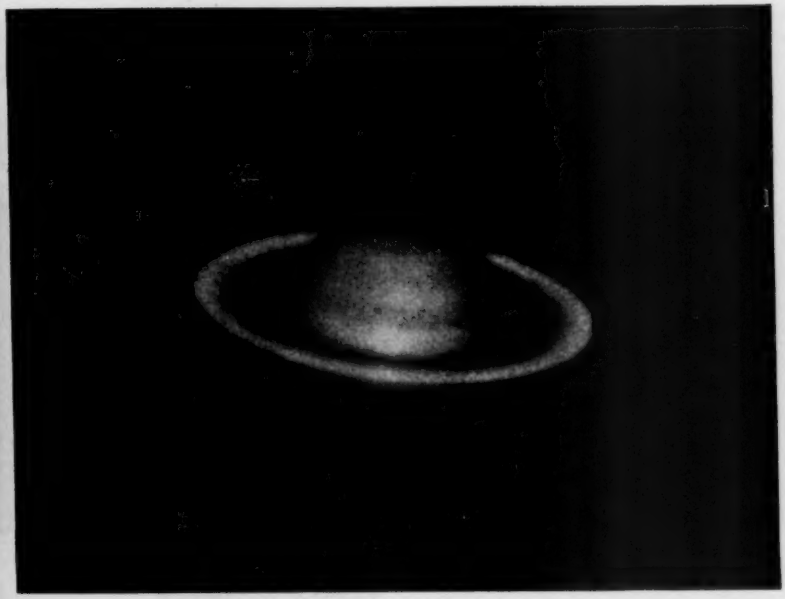


Fig. 2. Objects included in the film *Looking Through Great Telescopes*. Top—Saturn taken with 60-inch reflector at Mount Wilson. Bottom—The Dark Horse Head marking in Orion.

JOHN WOLF, ILLINOIS NATURALIST

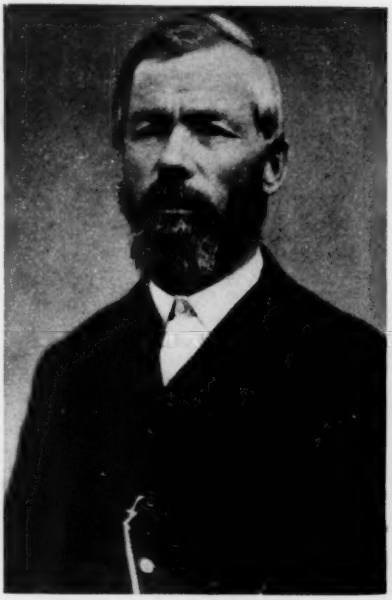
MARGARET MIDDLETON

Canton High School, Canton, Illinois

A FADED DOCUMENT inscribed in German, from the United States Consulate at Bremen, under the date of May 30, 1833 is a passport "guaranteeing to John Wolf and wife and seven children of Mittelsinn, Department of Urbs, Bavaria, satisfactory traveling conditions and friendly reception to the United States"; this passport, issued to the father of the Illinois naturalist, plus obituary notices and the recollections of two of his nephews, one niece, and a few older residents of Canton, furnish practically all of the foundation for this biography of Professor John Wolf, noted Illinois Naturalist.

John Wolf was born in Mittelsinn, Bavaria, on January 28, 1820, in the abovementioned family of seven children —six boys and one girl. It is interesting to note that all of the brothers were named John, though they were called by their middle names in order to distinguish them from this John. In 1833, the whole family, crossing the Atlantic Ocean in a sailboat, came to this country and settled near Bedford, Pennsylvania. It is probable that they farmed, since one son later became a very successful farmer southeast of Canton, Illinois, near Monterey.

The family migrated to Illinois in the Civil War period and settled in Canton. According to a newspaper article written at the time of his death and to reports of several older residents of Canton, the brothers took up the occupation of cobbler and John carried on a shoemaking business in a small brick building on West Elm Street. However, Mr. Charles Wolf, a nephew of John Wolf's, thinks this report erroneous. According to him, the "eldest son (Reverend George Wolf, who died at Garden City, Kansas, some years ago after a notable career as minister, author and missionary to the Indians of California) was a cobbler who later mastered seven languages. Another brother was apprenticed (bound out as they then called it) to a shoemaker. He



JOHN WOLF
1820-1897

mastered six languages and became also an expert at penmanship and freehand pen-and-ink drawing which he taught in business colleges. If the father had been a shoemaker, the son would not have been 'bound out' to learn the trade. His history and that of his brother George led to the assumption that the family were shoemaking people and that Professor John Wolf was a cobbler."

John and his sister Barbara remained at home and cared for their parents until the death of the latter in the late sixties. At one time John was engaged to be married to Miss Mary Glass, but they quarreled and he remained a bachelor. Throughout his life he had a deadly fear

of women. After his death, a close friend wrote: "What has happened to him in heaven, where there are so many (women), is a matter of deep conjecture."

It was during the period of his life at home as youth and man that John merged into a naturalist and became a linguist. That he attended any institution of higher learning is a matter of doubt. In fact, he always was held up as an example of self-education. Newspaper reports of his death say that "He was self-taught, loving learning for its own sake and, especially attracted toward the natural sciences, he ploddingly, perseverengly, untiringly read, studied and examined until his chosen field was fairly conquered." Where or how he got his books or what became of them is not known. His nephew has a faint impression that he taught a country school for a period. He could read fluently in thirty languages but could speak only a dozen correctly, which was a great sorrow to him.

Mr. Charles Wolf writes me that "It is a matter of record that John Wolf went to the Black Hills as an accredited government assayer when gold was discovered in that region in 1874. He remained there for several years and returned to Canton with forty thousand dollars—a fortune in those days." Does this perhaps refer to Wheeler's expedition in Colorado in 1873 on which he was a field assistant?

On his return to Canton, Mr. Wolf invested in a small one-story brick building on Elm Street just back of what was then the Hoblett Bank. His building was rented as a tailor shop for many years and produced part of his income. He never worked after his return but devoted his life to his beloved hobbies—botany and geology. He spent his entire time in the collecting, studying, classifying and cataloguing of botanical, entomological and geological specimens.

About this time he started his museum over Blackadore's harness shop midway on the north side of the public square in Canton. It was then that he began to be called "professor" by the general public. His museum was not large but consisted of collections of specimens made partly by himself and partly obtained by exchanges with other naturalists. His collection of the flora and minerals of Illinois was most comprehensive and accurately classified and was unsurpassed for many years. It probably never was surpassed by later botanists. He was not a world traveler but roamed widely over the State of Illinois with a large tin vasculum strung over his shoulder for the carrying of specimens. Children, who had overcome their fear of this "crazy" scientist, often accompanied him on his collecting trips. His Illinois collection was ever the main feature of his museum, though he made it more cosmopolitan by adding corals, sea-shells, stone-age relics, ores, and geological specimens from far and wide. Mr. Charles Wolf recalls his giving him in later years, some rare trilobites and some beautiful calamites which John Wolf "fondled as if they were diamonds." He also recalls going with him on one of his fall rambles when he was eight years old and John about fifty-six. "He was so vigorous I could scarcely keep up with him. We ate lunch under a shellbark hickory tree from which the nuts were dropping. After lunch he picked up what seemed to be a perfectly huge log and used it as a battering ram to jolt the shellbark and bring down a veritable shower of nuts which he left me to pick up while he roamed about inspecting fungi and other botanical phenomena."

Professor John Wolf was six feet tall and powerfully built. His hair and eyes were dark and his complexion was ruddy. He had a long beard, and a rather prominent nose. His sunburnt complexion might have led strangers to think him a drinking man—which he was not. In fact, he had strong prejudices against smoking, drinking and profanity. About town he always wore a somewhat shiny Prince Albert coat and a scuffed black silk hat. Being generally immersed in his beloved hobbies, he was somewhat unsocial and consequently often misunderstood. An interesting anecdote tells of an invitation he received to visit a famous scientist in Washington, D. C. He dressed in his usual costume, packed his traveling paraphernalia in a handkerchief, and set out for the distant city. Upon arrival at the home of the scientist, he was met at the door by the butler who was not going to admit him. He finally did, but Mr. Wolf was not asked to stay!

A few mannerisms and idiosyncrasies, which he was too independent to correct, placed Mr. Wolf in the category of a "prophet without honor in his own land." Present residents of Canton re-

member being frightened by him as children for they thought he was crazy! However, he was well-known to the Smithsonian Institute where there is a good sized sheaf of correspondence between Dr. George Vasey, first Curator of the United States National Herbarium and Mr. Wolf. He was also a close associate of Professor Starr of Chicago and a friend of Asa Gray of Harvard from whom he received honorable mention for specimens contributed.

A notable activity of his late years was research work in genealogy—in the course of which he traced his own lineage to the House of Guelph (Welf), a family which rose in the eleventh century and later contested fiercely with the Ghibelines for dominance in Bavaria and Italy, the Guelphs putting rulers on various European thrones, including the Bavarian and English. George of Hanover, who ascended the English throne in 1714, was a Guelph. The blood of the Guelphs flowed in the veins of Queen Victoria and flows today in the veins of her great grandson who sits on the British throne.

Dr. J. E. Coleman, in a short history of Canton, wrote that "John would sit in his chair on the sidewalk in front of his office most of the warm afternoons with eyes closed, going over materials in his mind for a book he was writing on philology. He completed the book before he died and it looked like an engraving, so accurately and neatly was it printed by hand." This book, however, was never published.

Mr. Wolf appears to have published but little. The card catalogue record of the United States Department of Agriculture Library is as follows:

A list of the Mosses, Liverworts and Lichens of Illinois. Bulletin of the Illinois State Laboratory of Natural History, Vol. 1, Part 2, pp. 18-35. 1878.

List of Trees and Shrubs in Fulton County. Geological Survey of Illinois, Vol. 4, pp. 109-110. 1875.

He discovered two new grasses, both of which were named after him: Sporobolus Wolfii (**Vilfa minima**) and Graphephorum Wolfii (**Trisetum Gilfii**).

Professor Wolf died at the home of Mr. and Mrs. Delbert Williamson, where he boarded, August 27, 1897. He was a deeply religious man and a lifelong member of the Presbyterian Church. He left his collections and real estate to the First Presbyterian Church of Canton. There is a plaque to him on the communion table of the church. Before his death he had found that it did not pay to exhibit his treasured specimens and many of them were ultimately sold. The Presbyterian Church later presented his collections to the Canton High School, where it was literally "thrown around" in the attics of the school for years. The past year, with the aid of the Canton Board of Education, Superintendent Ben Kietzman and Principal Oliver L. Rapp, I have been attempting to clean and arrange these specimens in a museum in the high school. Many have diseappeared and most of the labels and all of the catalogue are missing. The Illinois grass, moss, lichen, and fungi collections, which were in a deplorable condition, have been loaned by the Board of Education to the Botanical Herbarium of the University of Illinois for ten years and is being cared for there.

John Wolf led an unselfish life and was loved by all. His charitable work among the poor was unostentatious, but nevertheless he assisted many families through hardships and suffering. The following is taken from a tribute "to the life and character of John Wolf by a friend," published in the Canton Daily Register after his death:

> "To him the study of nature was a perpetual delight. The tiny blade of grass, the minute petal, the little pebble told a story that appealed most strongly to his nature and that fastened him spellbound, entranced. The woods were his temples, the fields his shrines and he did homage there to the universal God, whose works are in no other sphere more wonderfully illustrated than in the great domain of nature.
>
> "For years he traveled over hill and dale, neither asking nor seeking pecuniary rewards, only intent on adding to the rich store house of his chosen profession. His was an unselfish life and he gladly made personal sacrifices that science might be the gainer. He lived not for himself but for others. Posterity will not forget him. Science, enriched, ennobled by his labors, will ever do him tribute. Humanity, the beneficiary of his kindly heart, will ever claim him as his own."—G. B. Grant.

To Mr. Wolf's niece, Mrs. Laura Snyder of Canton, Illinois, and his nephew, Mr. Charles Wolf of Seattle, Washington, the writer is indebted for most of the facts recorded here.

MEMOIRS

HENRY CHANDLER COWLES
1869-1939

HENRY CHANDLER COWLES was born at Kensington, Connecticut, on February 27, 1869. He died at his home in Chicago, Illinois, on September 12, 1939, after a prolonged illness. He received his early education in the public schools and in the New Britain High School. He entered Oberlin College and was graduated with the degree of A. B. in 1893. He taught natural science at Gates College during 1894-95, and held a fellowship at the University of Chicago during 1895-96. His graduate studies were begun there in geology, but upon the appointment of the late John M. Coulter as professor of botany, he became a member of the first group in that science at the University of Chicago. He received the degree of doctor of philosophy in 1898, presenting as his thesis his classical paper on the vegetation of the sand dunes of Lake Michigan. He then attempted to apply the principles of dynamic vegetation, so evident in sand dunes, to vegetation in general. The resulting "Physiographic Ecology of Chicago and Vicinity" formulated a philosophy of vegetation in which the central principle was that classification to be valid must be genetic and dynamic. In this monograph the concepts of succession and climax were for the first time adequately expressed. The principles thus enunciated were so vital and so fundamentally important that scores of graduate students were later guided in their researches by these two early publications.

In 1897 he became an assistant in the newly organized department of botany in the University of Chicago. From that time onward he was advanced repeatedly in rank until in 1911 he became professor, and in 1925 chairman of the department, a position he held until his retirement in 1934. In 1926 he became editor of the Botanical Gazette, a task in which he had assisted for many previous years and relinquished only at his retirement. His alma mater, Oberlin College, gave him the honorary degree of Sc.D. in 1923.

He began teaching plant ecology at the University of Chicago to an enthusiastic group of students in 1897. From the start he was a remarkably successful teacher and he promptly became a recognized leader. The regional and geographic aspects of ecology were always happily emphasized in his lectures and he kept the research spirit alive in his classes. He soon gathered about him a group of men and women who have gone on to extend his methods and concepts throughout the land, developing in this country one of the world's most active centers of ecological study. In 1914 the Ecological Society of America was organized, largely through the efforts of Cowles and his former students. Cowles was its first secretary-treasurer, its president in 1917 and always a wise counselor regarding its welfare.

His world-wide leadership in the field of plant ecology was recognized in 1930, when at the International Congress,

meeting at Cambridge, England, he was made president of the section of phytogeography and ecology.

In 1911 appeared the "Chicago Text Book of Botany" in two volumes, afterwards expanded to three. Cowles contributed the volume dealing with ecology covering the branch of the subject known as autecology. In it the theory of mechanical causation was stressed rather than teleology and adaptation which had previously been somewhat widely accepted.

No teacher brought his students more directly to nature than Cowles. Field trips, varying in length from one day to many weeks, inspired others to use the out-of-doors classroom. This led to his useful activities in all lines of conservation. No one was more influential than he in establishing the State Park system of Illinois and the Forest Preserves of Cook County, Illinois. For many years he was president of the Chicago Academy of Sciences. He was also a patron and trustee of the Geographic Society of Chicago and president of the society for a term of years. He was a charter member of the Illinois State Academy of Science and at its first regular meeting, held at Decatur in 1908, Cowles presented a paper stressing the desirability of a systematic ecological survey of the state. He served as president of the organization for the year 1920-21 and was always interested in its welfare. For many years he was a member of the Board of Natural Resources and Conservation of the State of Illinois.

A member of many other scientific societies, he served as president of the Association of American Geographers in 1910, as president of the Botanical Society of America in 1922 and vice-president of Section G of the American Association for the Advancement of Science in 1913.

In 1935 the July issue of Ecology, the official journal of the Ecological Society, was dedicated to Cowles by his students and friends. It was filled with articles from students and colleagues from America and from several European countries. From an appreciation of their friend and teacher, written for that issue of Ecology by W. S. Cooper, we quote the following paragraph:

"A man may be a great scientist and a great teacher and yet inspire in his colleagues and students little affection or none at all. With Cowles it was far otherwise. Something more than mere respect for high scientific attainment is necessary to account for the fact that, when the plan of this special number of Ecology was made public, more than three hundred persons responded. With almost every contribution came a letter expressing admiration for Cowles as a scientist, as a teacher, and above all, as a man. These facts speak for themselves; formal tribute is superfluous. And yet, merely because it is a joy to do so, we make mention of a few of his many lovable traits—his unfailing good humor, his far-famed ability in telling a story, his readiness to give ungrudgingly of time and effort in the service of students and friends, his eagerness to discover and commend whatever was meritorious in the work of a fellow scientist or admirable in the man himself.

"He relinquished his active labors secure in the consciousness of work well done, confident of achievement beyond the ordinary lot. He laid the foundation for a new and useful branch of science, he constructively influenced the thought of hundreds of investigators and teachers, and in his professional and personal contacts he made for himself a multitude of devoted friends."

George D. Fuller.

MABEL ELIZABETH SMALLWOOD

1867-1939

WHEN A WOMAN has devoted all the active years of her life conscientiously, whole-heartedly, and affectionately to teaching the youth of a great city, no one can, with any degree of adequacy, give a proper eulogy. And when the subject she taught was biology, the science of life, which she was so well prepared to teach, no one can measure her value. Starting from an American farm in western New York, she attended centers of scientific learning such as the University of Chicago, Cold Spring Harbor, Woods Hole, and augmented this formal training with invaluable hours of reading in her own library from choice works of science and travel, and with delightful and purposeful study of the out-of-doors. She had the unusual gift of imparting to her pupils not only the facts of science and how to find more for themselves, but how to think on those facts. Her value to society is written indelibly in the lives of many of our country's citizens and young scientists.

Miss Smallwood was one of the first biology teachers to keep living things in the laboratory. Her pupils saw and helped care for a succession of animals —all who could be comfortably housed and well fed in a school room. There were tropical, native, and gold fish; turtles, salamanders, toads, ring-necked doves, white and hooded rats, guinea pigs and rabbits. It was her special delight to watch the smile on a boy's face when for the first time he held a pet bird or mammal in his hands and simultaneously opened his heart to the love of Nature. She was one of the first science teachers to plan a course in biology instead of botany and zoology—to adapt the subject to the needs of the pupils that they might know by name the living things they saw daily and feel acquainted with them.

Her sincere love for her fellowmen was another outstanding quality. It came from a scientific attitude of helping each individual to make the most of his hereditary qualities and a fundamental love of democracy handed down to her from a grandfather who landed in 1819 in Alexandria, Virginia. He fled from oppression and class prejudice abroad, and at his first sight of slavery packed his family and belongings in a wagon, moved to New York, and was an active abolitionist till the slaves were freed. Elizabeth was a worthy granddaughter. Position, wealth, race, age or youth counted as nothing with her. She judged all men equally on standards of honesty and justice. Her gracious manner and smile of friendship were extended to all alike. It is fitting that at the close of her life her relatives and fellow teachers, her pupils, friends, and those who served her in various capacities, all join in the common testimonial, "We loved her."

Doris A. Plapp.